Support for the project "Erosion control on the island of Rodrigues". Evaluation of livestock husbandry and proposals for action.

A visit made to Rodrigues island from 26 October to 5 November 1999.

Paillat J.-M., November 1999

photo : J. Castagnet

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SUMMARY

Location of the project and livestock problems

Terms of reference

The general aim of this visit, which was financed by Vakakis International SA, was to contribute to the implementation of the project "Erosion control in Rodrigues". The planned programme (annexe 1) was largely followed, but the report differs somewhat from the stated terms of reference. Certain points could not be dealt with during this visit, such as costs and benefits of changing husbandry systems and the marketing of livestock products. These aspects will have to be addressed by specific complementary studies (e.g. for marketing) or as part of the execution of the project (e.g. economics of husbandry systems).

The "erosion control" project

Soil erosion in Rodrigues is a particularly visible phenomenon throughout the whole island. Abuse of soils, failure to install control measures during land planning and poor water management, which also results in loss of water for domestic and agricultural purposes, are the main causes, for example: cultivation of degraded terraces, overgrazing by animals, houses and their outbuildings (small livestock units), roads and various public works. Downstream, the lagoon is a very sensitive ecosystem which can suffer severe damage from erosion products.

In these circumstances, and as a result of several projects financed by EDF[1] loans, the "Erosion control project", financed by the Government of Mauritius and the European Union, foresees developments and infrastructures grouped within four programmes (Angé, 1999a): (i) creation of a nature reserve in the hills, (ii) planning the watersheds, using a participatory approach involving the local people, (iii) experimental waterworks at the bottom of a valley, and (iv) coastal restoration.

As part of the establishment of this project, the objective of the October Vakakis/Cirad visit was to help the national director of the project and the project director to set up a four-year work programme. The "livestock husbandry" visit was made to help a group of experts charged with preparing the Overall Work Plan (OWP) to decide on the animal husbandry actions to be implemented within the project.

Problems caused by livestock rearing

Livestock rearing is targeted as one of the main causes of soil erosion in Rodrigues. Too many animals graze limited forage resources, as grazing is no longer controlled.

More than thirty years ago, to answer the social demand for food, the English colonial administration instituted "cattle regulation" and demarcated part of the island as a "cattle walk". This rule obliged livestock owners to graze their animals in the lower, less fertile and more arid parts of the island so as to reserve the fertile, wetter areas at medium-high altitude (150-300 m), most of which were laid out between the forties and seventies as stone-walled terraces for growing food crops (maize, cassava, sweet potato). Grazing was then forbidden in these hill areas; the animals which were fattened there remained tethered or in compounds, being hand fed.

In the seventies, several successive years of severe drought occurred which forced the authorities to end the cattle regulation in order to allow the animals to graze the more productive pastures on the high ground (Allas, 1999). Since that time, the "cattle walk" area originally demarcated has been ignored, and grazing has been practiced all over the island. The land, 96% of which belongs to the state (Angé, 1999a) is thus farmed collectively by the breeders who develop their livestock "capital" without worrying about the resource available or the damage caused to the terraces abandoned to grazing or to the crops remaining on some of them, leading to conflicts between farmers and breeders.

Also, for several years, problems with selling beef on the Mauritian market, especially from culled cows, together with the social role of these animals, which are regarded as capital on the hoof, and the refusal of breeders to sell their animals cheaply, have led to a large increase in the number of females. The number of cattle on the island has become much too great in relation to the amount of grazing, leading to a succession of damage which forms a chain from grazing through forage resources, animals, soils, water and finally the lagoon.

[1] European Development Fund

The "livestock breeding" visit therefore had the objective of reviewing husbandry conditions to roughly assess the potential of the environment and to propose solutions to the overgrazing problem.

The livestock situation in Rodrigues

General aspects

The island of Rodrigues, situated east north-east of the island of Mauritius to which it belongs (63°20' E, 19°40' S) (Tirvengadum *et al.*, 1993) has an area of 108 km^2 (16.5 x 7.5 km) and had a population of 35332 inhabitants in 1998 (Republic of Mauritius, 1999). This population has been quite stable since 1988 because of emigration to Mauritius. However, in view of the pyramidal age distribution (46% of the population below 20 years of age), an increase in population is expected to 12000 families and 43800 inhabitants by 2010 (Hemoo R., 1997).

The island is formed from two overlapping volcanoes with craters and rivers which flow down all the slopes. The western volcano is the older and more eroded. Numerous peaks exceed 300 m in height, the tallest being Mt Limon (396 m). This mountain is made up of numerous watersheds, of variable size and steepness (Angé, 1999b). The evolution and erosion of the soils, the state of the terraces and the slope govern the very variable agricultural potential of each area. According to Tirvengadum *et al.* (1993), 1200 ha of soils have a high potential, 900 ha an average potential, 2100 ha a low potential and 6000 ha a very low potential. As regards their exploitation, 2100 ha are well managed, 2000 ha could be improved and 3000 ha are under forest.

The rainfall, which is greatest from December to April, has an annual mean of 1600 mm in the hilly areas which are cool during the southern hemisphere winter and 1000 mm in the coastal areas in the west (Tirvengadum *et al.*, 1993). The island is subject to cyclones and especially droughts which can be very severe from September until the end of January. Arnold (1984) noted 2-3 droughts per decade. The 1983 drought was responsible for the death of 1000-1400 cattle, or 15% of the herd. According to the veterinary services, that of 1998 killed 400 cattle (recorded deaths), but it is estimated that the true number was far greater (1000 head or 10% of the herd), and there were other effects, such as disease problems, calving difficulties and loss of fertility. Sheep were less affected as they have lower demands and can graze more closely.

The potentialities of the soils and climatic characteristics therefore define the conditions for forage production and stock rearing in the different regions. 4900 people are employed in agriculture, and for many years livestock rearing has been the main agricultural activity in Rodrigues: 3000 families out of 7900 (in 1995), or 38%, rear livestock (Hemoo R., 1997). The decline in agricultural crop production began in the eighties (Tirvengadum *et al.* 1993) and has accelerated since 1990: 1800 ha in 1970, 1200 in 1990 and 370 in 1998 (Republic of Mauritius, 1999). In fact crops, originally developed to provide for the needs of the population, are declining steadily (annexe 2). There seem to be two major reasons for this decline: (i) soil fertility falls because of erosion and the almost total absence of crop rotation (Maize monoculture is the norm). (ii) Human food requirements are increasingly met by subsidised rice imports via Mauritius. Some market garden and fruit crops, representing only small area, are however beginning to be grown, notably on the irrigated parts of valley bottoms.

Farming systems

In spite of the small size of the island, the farming systems, mainly involving stock rearing, are numerous and complex because many farmers have several other jobs. A big proportion of the population have other jobs as shopkeepers, civil servants, employees or labourers, fishermen, farmers or stockbreeders. Also, the production systems are very interwoven: most families have two or three cows, one or two pigs, goats, sheep and poultry; they also grow crops such as maize, sweet potato and onion. Some families however have much bigger herds: up to 40 head of cattle or more than 100 head of sheep. Berthelot *et al.* (1992) have classified agricultural systems in Rodrigues and studied their dynamics. Based on income and its origin, they suggest that there are six types of farmer. The families of types 1, 2 and 3 have income other than from farming which may be small (type 1), moderate (type 2) or large (type 3). Families of types 4, 5 and 6 have little or no non-farming income, but their situation differs greatly. Some of them practice near-subsistence farming (type 4) whereas others have taken up commercial agriculture (type 6). Type 5 is intermediate.

The farming systems and other activities conform with the socio-economic and soil/climatic aspects. Hence, in order better to define the forage production potential of the different areas and the husbandry conditions, we will describe a zoning system based on altitude, rainfall, topography and land use capability, produced by Govinden *et al.*(1996) to help town planners and agricultural services in the allocation of leases and for extension work.. In this classification, which was greatly improved by the analysis of catchment areas made by Angé (1999b), nine main zones are distinguished:
- at high altitude, flat zones (A1) and fertile (A21) or infertile (A22) slopes ,
- at medium altitude, sub-humid flat zones (B1) and sub-humid slopes (B2),
- at low altitude, dry coastal plains (C11), irrigated (C121) or unirrigated valley bottoms (C122) and dry coastal slopes (C2).

In the field during the visit, we could roughly assess the interaction between the soil and climatic aspects which determine the agricultural potential and the socio-economic aspects. In fact it shows up quite clearly (in terms of housing, herd size, condition of the animals, cultural practices) that the sloping and/or dry areas (B2, C11, C122 and C2) are occupied by low-income farmers (types 1 and 4), while the plateau zones (Ax) and the irrigated valley bottoms (C121) contain farming systems which appear more remunerative (types 2, 3 and 6). In the intermediate zones (B1), the farmers' situations seem more diverse (type 2 and 5). This observation is of course subjective and should be confirmed or refuted by a sociological study. Nevertheless, it is important to policies concerned with destocking animals and for land planning which may be involved in this project.

Despite the large amount of unemployment on Rodrigues (estimated at 40%), shortage of labour for farming operations seems to be common in certain systems. The practice of multiple jobholding and the relative profitability of the different activities are often the reason; hence the rapid decrease in crop husbandry at the expense of very extensive stock rearing with its low labour requirement.

Cattle farming

Cattle farming is very important on Rodrigues both culturally and economically. In fact it provides the main export product, with a mean (90-98) of 1074 cattle exported per annum and about 300 officially slaughtered locally (annexe 3). Production is the work of a very large number of breeders who possess on average very few animals: fewer than five head per herd in 1995 according to data reported by De Schrevel (1996), based on a census by the agricultural services. 72% of the breeders have fewer than 5 head, making up 40% of the animals, 20% have between 5 and 10 head, or 30% of the animals, and 8% have more than 10 head, or 30% of the animals (annexe 4). The herd is made up of different breeds consisting mainly of Creole zebus, but also larger breeds, such as Brahman and South African breeds.

This breeding is practised for the capital value and not directly for the production. Beef is sold when money is needed, notably for festivities (End of Year, weddings etc). The herd is passed on from father to son (the father gives 1 or 2 animals when one of his sons sets up home): for this reason the herd increases even though the amount of pasture and its productivity remain the same. For the large breeders, the productive aspect is not even considered. Livestock is capital on the hoof which is useful when times are bad, particularly for shopkeepers and some civil servants.

The meat market is under the total control of butchers who come to Rodrigues to buy animals on the hoof for slaughter in Mauritius. They want mainly uncastrated, well fattened males for the Moslem market. Females and poorly developed animals are of very little value, the price offered by the butchers for this type of animal being of no interest to the breeders who thus prefer to keep the animal as capital. The consumption of beef in Rodrigues is very low: in the order of 1 to 1.5 kg per person per year (the Rodriguans eat beef about once a month).

Also, for several years, Mauritius has tried to open its markets to the outside world. There is no longer any protection from imports. As a consequence, frozen meat is imported from India at a very low price and animals are imported from Madagascar and Africa. What is more, these imported animals are, it is said, in better shape than those from Rodrigues. This being so, the Rodriguan market is doomed. Agreements have therefore had to be made between the Rodriguan producers and the MMA (Mauritius Meat Authority) to (i) oblige the butchers to continue their purchases on Rodrigues, and (ii) to begin destocking females, the MMA being responsible to resell them directly or to fatten them in Mauritius. However, these animals are worth very little (5000 Rs for a

cull cow of 250 kg compared with 15000 Rs for a young male of 350 kg), and the price which the Rodriguan breeders ask is too high. Furthermore, the butchers were channelling the better animals through their intermediaries for a slightly better price than that of the MMA, which had the effect of making the breeders lose interest in intervention. After two years of destocking, the MMA, being no longer able to sustain this operation, had to stop its intervention. The process was restarted in 1999 by the agricultural services, which have an officer responsible for destocking. The breeders, aware of the problems arising from the drought at the end of 1998, bring their animals to the livestock stations of the agricultural services, but the butchers are not interested and do not come to buy. Consequently, the destocking programme is at a standstill.

The result of this type of market and the marketing problems due to the size of the animals or to their state of fattening is the accumulation on Rodrigues of a large herd of cows. The island is thus regularly burdened with an excess of animals with the problems of overgrazing and erosion which result. The frequent severe droughts then decimate the cattle herd. The figures recorded show a mortality of 10% of the herd with every drought. This "natural" regulation reverberates over several years since during these periods, many young animals die and the fertility of the females falls, which slows down the process of replacement. This then affects the males, and thus reduces the possible market valuation.

The structure of the herds is thus the result of this phenomenon of accumulation and death. Unfortunately we were not able to record the actual changes in the herd during the visit because of lack of data for several years. However, a census of the animals is always made by the veterinary services: in principle the animals are tagged and the tags are recorded at slaughter or at the time of sale. It is therefore necessary that the agricultural services carry out a precise analysis of the information collected in this census. For this technical report, our information and recommendations are based on the 1995 census; we assume that as far as these aspects are concerned, the situation has changed little. The data which we presented to the veterinary surgeon seemed to him fairly correct, as did the changes which we were able to simulate (cf para "General diagnosis"). In 1995, the herd consisted of 6914 females with an average age of 3.9 years and 2895 males with an average age of 1.7 years. As calvings were counted in 1995, the cows, of an average age of 5.5 years, give birth to two calves every three years on average (0.7 calves per year); the first calving takes place mostly towards four years and the cows have on average two calves: the great majority of cows aged over three years have between one and three calves. Many cows older than seven years have still had only one or two calves (annexe 5).

There is also some milk production which is of little importance in Rodrigues: about thirty animals belonging to several breeders with a very low productivity per cow. Several members of Facer[2] believe however that this industry could be developed, as there is a demand for fresh milk in Rodrigues.

Sheep and goat husbandry

Sheep rearing developed considerably until the nineties, apparently with periods of recession, possibly due to drought. Censuses, which should be treated with caution, record 5000 to 6000 sheep in the eighties until the start of the nineties (Govinden, 1996). Since then the sheep count has fallen to reach 3855 in 1998 (Saddul, 1998). The total flock is made up of 294 rams, 1913 ewes and 1648 lambs more than a year old. These are small animals: 35 kg on average for the males, 29 for the females and 25 for the lambs. Husbandry is minimal except for disease control (treatment for internal and external parasites): there is no separation of males and females; the young ewes are often mated too young and there is inbreeding in the flock. A ewe produces on average 1.4 lambs each year and is culled towards the age of four years. Selected rams were made available to breeders a few years ago. However the breeders preferred to sell their products rather than continue the selection as it was more profitable.

59% of sheep breeders have fewer than 10 sheep, 30% have between 10 and 40, 9% have 40-100 and only 2% have more than 100 (Saddul, 1998). As in the case of cattle, production is thus very fragmented and often very extensive, using rough grazing with poor forage potential.

Sheep exports to Mauritius continue to decrease (annexe 3): from 4330 animals in 1989 to 1132 in 1998 (Abstract of statistical data on Rodrigues, 1998). The reasons for this decrease seem more related to husbandry and to the interest of the breeders than to marketing problems. In fact, unlike beef, Rodriguan mutton finds buyers quite easily in Mauritius. According to certain officers questioned, it would be possible to develop this

[2] Federation of Cooperative Associations of Rodriguan Breeders

production as a partial substitute for cattle raising (after major destocking of the cattle): the MMA reports a potential for marketing 4000 more animals (De Schrevel, 1996). Factors mentioned as hindering production are deaths caused by stray dogs and lack of technical training. The profitability of this type of farming seems however to be as good as that of cattle rearing.

Goats are less numerous and are kept in even smaller herds. According to De Schrevel (1996), there were 335 goat breeders in 1995 with 1776 animals (562 bucks, 988 she-goats and 226 kids under 6 months of age), i.e. on average rather more than 5 animals per herd. These numbers seem to have remained very constant for about ten years: 1196 animals were exported on average (90-98) (annexe 3).

Rearing pigs and poultry

Apart from a few more intensive poultry units, the rearing of pigs and poultry is a family courtyard enterprise. In 1995, 4223 pigs (including 1863 sows) and about 30,000 chickens were recorded for 1433 farmers (De Schrevel, 1996). These animals are very rarely housed. They range freely in the farm courtyard, or, in the case of pigs, are tethered. The meat from these animals is the most highly valued in Rodrigues: it is eaten at least once a week, often at the weekend.

The numbers of pigs seem to have fallen markedly over the last decade: about 9000 animals were recorded around 1985 (Blokland and Harteveld, 1987). Exports have fallen sharply for several years (annexe 3), from more than 2000 in 1994 to less than 100 in 1998 (Abstract of statistical data on Rodrigues, 1998). However, official local slaughtering has increased from less than 1500 in 1995 to more than 2000 in 1998. Also, pigs are often slaughtered on the farm. It is therefore difficult to keep track of this production. The reason for the fall in exports seems to be the poor conformation of the Rodriguan animals due to the primitive husbandry conditions, with no pigsties and a diet of household scraps. Using concentrates, the cost of fattening pigs is greater than the price paid to the breeder, which is a strong deterrent to sale for export and favours local processing in small delicatessens or at home. It is noted that the method of rearing in farm courtyards is a major cause of degradation (erosion) of areas around houses.

For poultry, exports to Mauritius have been fairly steady for about a decade (annexe 3): about 25000 fowls per annum. As in the case of pigs, consumption of farm-raised chickens is considerable, but difficult to estimate. For some time there has been laying hen unit which supplies practically the entire Rodriguan demand for fresh eggs.

In the follow-up from our report, we will be less interested in these animals which have little to do with the pasture resources of the island and thus pose no problems as regards matching up these resources with livestock requirements.

General diagnosis and recommendations for livestock husbandry in Rodrigues

Forage crop potential

Faced with the problems of overgrazing and cattle malnutrition during the dry season, the first factor to be addressed is that of the productivity of the pastures grazed by the ruminants. It is worth noting that according to people we met, this year, unlike last, the rain which fell in October and November was enough to keep the vegetation fairly green, although very little biomass was produced. The years are thus very variable, and it is difficult to give a precise figure for potential forage production, especially as hardly any measurements of herbage production have been made in the field. (Some data are being collected by the agricultural services in the "cattle walk" area). We shall therefore have to be content with estimates, accepting a considerable degree of uncertainty.

As a result of visiting different parts of the island during the visit, and by cross-checking with the soil map, we have been able to define different zones (table 1) which contain varying amounts of pasture, and to attribute a minimum and maximum forage potential to them, estimated from experience in La Réunion, and bearing in mind that none of them are fertilised, together with a mean surface area, calculated approximately on the soil map.

Table 1: estimation of forage potential in the different areas of the island

N°	Type	Altitude (m)	Potential (t DM[3] / ha / yr) minimum	maximum	Area (ha)
1	Stony "cattle walk"	0 à 100	0,5	1	1640
2	"Cattle walk" on chalk	0 à 50	1	2	560
3	Fertile "Cattle walk"	0 à 50	2	3	560
4	Sloping terraced basaltic plateaux	< 200	3	4	980
5	Terraced upper valley regions	> 150	5	6	360
6	Crater bottoms	> 200	10	12	720
7	Irrigated valley bottoms	0 à 20	12	15	300
8	Cultivated areas	everywhere	0	2	400
9	Housing areas (highland)	> 200	0	2	300
10	Forest	everywhere	0	0,5	1600
11	Steep slopes	everywhere	0	0,5	3380
	Utilised agricultural area				5520

The UAA (Utilised Agricultural Area) which we have used corresponds to zones 1-8. The woodland pasture areas, currently under-utilised as they are only harvested in the dry season, are included in this UAA. The area of steep slopes was obtained by difference from the total area of the island (10800 ha). Zones 8 and 9 devoted to crops and wildlife can also be partly used by livestock by planting fodder hedges. For comparison, the figures provided by Tirvegadum *et al.* (1993) are similar to our estimates. These authors show:

- 1200 ha with a high potential which corresponds to zones 5, 6 and 7, i.e. 1380 ha with a potential above 6 t DM/ha/yr.,
- 900 ha with medium potential which corresponds to zone 4, i.e. 980 ha with a potential between 3 and 4 t DM/ha/yr.,
- 2100 ha with low potential which corresponds to zones 2, 3, 8 and 9, i.e. 1820 ha with a potential between 2 and 3 t DM/ha/yr.,
- 6600 ha with very low potential which corresponds to zones 1, 10 and 11, i.e. 6620 ha with a potential below 1 t DM/ha/yr.,

From these estimates of potential forage production and the areas, and assuming a variation of ± 20% around the given values, it is possible to work out the minimum and maximum forage production and to deduce from this the minimum and maximum stocking densities (annexe 6). According to the various hypotheses already proposed and without any improvement in the pastures in terms of production and management, the UAA of Rodrigues could produce between 12000 and 25000 t DM/yr, or a permissible stocking capacity from 4000 to 8300 TAU[4] (a mean of 7000 TAU); it is assumed that one TAU consumes 8 kg DM/day (Mémento de l'agronome, 1993), or about 3 t DM/yr.

Cattle destocking

The number of ruminants present on the island in 1995 was 9809 cattle, 2471 sheep and 1776 goats (De Schrevel, 1996). (1 cow corresponds to 0.5 AU or 1.0 TAU, 1 sheep corresponds to 0.1 AU or 0.2 TAU and one goat corresponds to 0.05 AU or 0.1 TAU). The present number is therefore in excess of 10500 TAU, i.e. considerably more than the maximum potential which we have calculated. Several authors talk about an admissible potential of 3000 cattle and 7000 sheep (Vink, 1981, *in* Blokland and Harteveld, 1987; Arnold, 1984), or 4400 TAU. This capacity corresponds to the minimum potential which we have estimated for severe drought conditions.

Faced with the problem of a mismatch between the requirements of the herd and the forage available, two solutions can be suggested: (i) to increase the resources; (ii) to reduce the stocking rate; or both. However, in the case of Rodrigues it is first necessary to decide whether the animals can be sold. According to people we spoke to, it seems that the beef market cannot absorb so many animals, or at least not ones which are poorly finished.

[3] Dry Matter

[4] Tropical Animal Unit, equivalent to 0.5 Animal Unit used in Europe, corresponding to a 600 kg dairy cow producing 5000 kg milk per annum

A market study (types of animal, conformation, degree of fattening, price, transport conditions and sale) is needed to get a better idea of the possibilities for selling the products of Rodriguan livestock rearing (cattle, sheep and goats) on the island of Mauritius. We therefore recommend that such a study be made without delay to enable a more precise judgement to be made on these aspects of ruminant rearing in Rodrigues.

Various solutions are possible to increase forage resources: conservation of surplus from the rainy season in the form of hay or silage; harvest of maize stems and their treatment with urea; intensive maize growing; purchase of sugar cane by-products and feeding concentrates. These different solutions have been introduced on La Réunion where there is a big demand for milk and meat (Paillat, 1995; Paillat and Hassoun, 1998); intensification is permitted because there is an assured outlet for the products. On Rodrigues, solutions of this kind, often costly, risk aggravating still further the difficulties with selling the animals.

In view of these difficulties, the emphasis should be on the second solution, that is to say destocking a large proportion of the herd (Moraby *et al.*, 1999). To return to an acceptable stocking rate, the effort should be concentrated on reducing the cattle numbers, the numbers of sheep and goats being more reasonable: besides, these animals apparently thrive more readily. To be really effective, this destocking, of about 4000 cattle, should serve several purposes: (i) reduce the stocking rate, (ii) restore the balance in the herd between males and females, and (iii) genetically improve the herd.

During the visit, we were able to simulate the possible changes in the herd until the year 2010 assuming two policies: (i) maintaining the present culling rate, and (ii) using a proposed accelerated culling for four years. These two scenarios are simulated using a simple model (annexe 7) based on the 1995 livestock census (age, sex), reproductive performance (age of cows at first calving, number of calvings per year). The annual sales (exports + slaughterings, obtained from agricultural statistics) plus the estimated mortality are taken into account to assign a culling coefficient for each year and each type of animal (figure 1). Without precise statistics, the male culling rates have been assumed to be relatively constant, causing the female culling rate to vary from about 750 to 1000 animals per year, except for 1999 where we took account of the drought and its repercussions on young male and female animals.

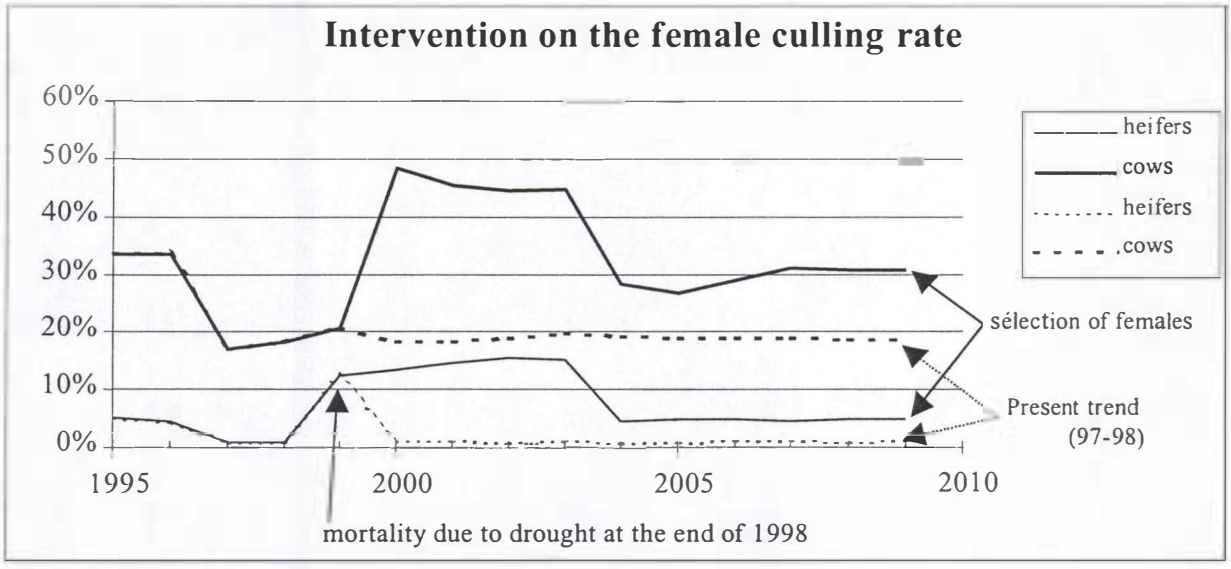

Figure 1: two possible scenarios for managing a female herd.

The female culling rate could be estimated in 1995 and 1996 at 18% (5% for heifers and 34% for cows) thanks to a destocking programme organised by the MMA during that period. Unfortunately it then fell to 8% (1% for heifers and 18% for cows) during the following two years, as intervention by the MMA was made more difficult. In 1999, the effect of the drought (estimated to have killed 1000 animals) was to cause "natural" destocking of 16% (12% heifers and 21% cows).

If the abnormally low culling rate of 8-9% recorded in 1998 were to be maintained ("present trend" scenario, with 19% cow culling and 1-2% heifer culling) the herd could run into trouble (figure 2) and the sales, both male

and female, would have to go on increasing (which is hardly compatible with the structure of the meat market) so as to keep the numbers steady.

If, as the "selection of females" scenario shows, it were agreed to modify the female culling rate from the year 2000 to 27% (45% for cows and 15% for heifers) for four years, one could hope to rapidly return to a herd size appropriate to the forage resources (figure 2) and to maintain it at about 6500 cattle present on the island, provided that thereafter the females are culled at a suitable rate of 15% (30% for cows and 5% for heifers). The cullings (exports + slaughterings on Rodrigues) also become constant at 1300 animals (620 females and 680 males).

It is therefore essential for the future of Rodrigues to put in place a policy for culling females. This will have short-term repercussions: a fall in numbers, improvement in quality of the remaining females, better fattened and more valuable males from the available resources, less mortality, especially among young animals, and in the longer term: better conformation of the herd, more valuable animals. This culling is worthwhile to achieve better management of the forage resources and to save the Rodriguan herd from a predictable decline which might prove irreversible, with badly formed animals in bad condition throughout most of the year, and a greatly increased death toll during droughts.

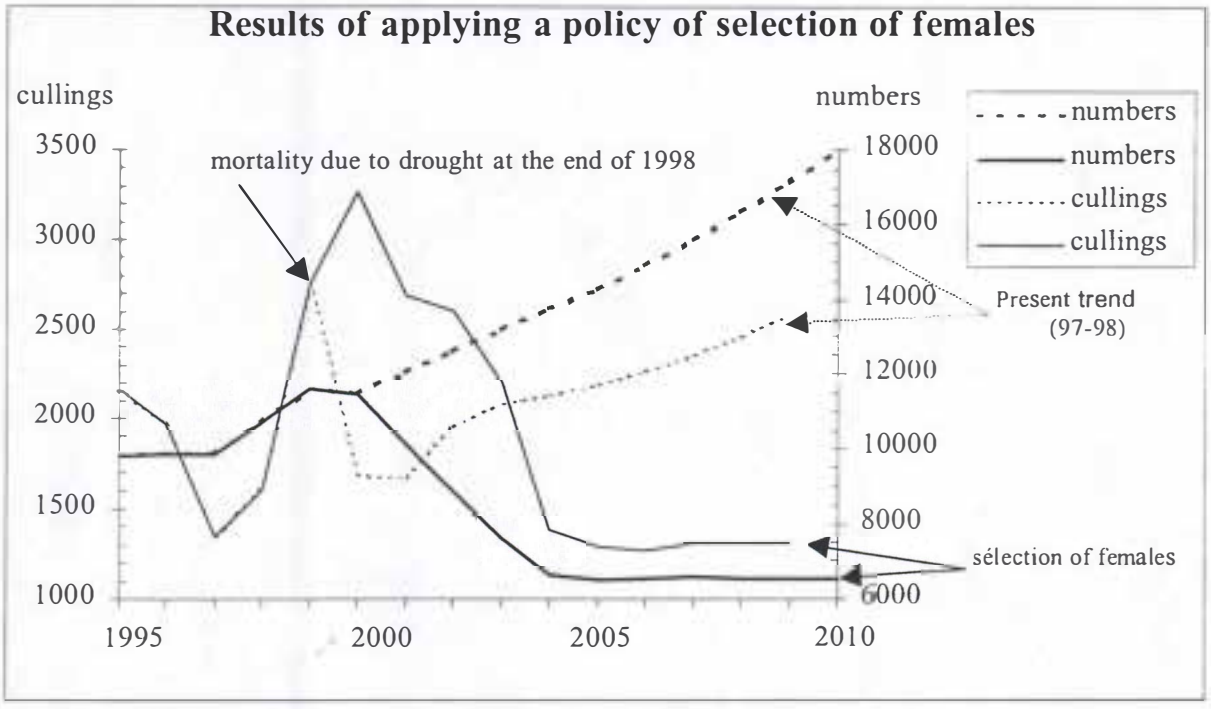

Figure 2: variation in cattle numbers and results on sales according to two simulated scenarios.

With the help of this diagnosis, it is necessary to find the most satisfactory solutions to achieve destocking. Without going into too much detail, assuming that the male animals present no problem as regards sale, and making use of the information and ideas provided by the people we met in the course of the visit, the following solutions may be suggested straight away:

- subsidising the sale of poorly-formed cows and calves. The Mauritian government should consider the consequences in terms of cost and the removal of responsibility from the Rodriguan breeders faced with the problem of the necessary destocking. The subsidy could be granted according to the social situation of the breeder in terms of numbers of animals: this solution has the merit of being able to be quickly put into action;
- increasing the export capacity for the Mauritius Pride, currently in the order of 200 ruminants per voyage. To achieve the proposed destocking, this would need a minimum of 250 places per voyage, simply for cattle; the transport could be free for lean animals to be fattened in Mauritius: the cost of transport would then be fully recovered from the fat animals; or else there could be a general subsidy for the transport;
- slaughter and direct sale of carcasses of poorly-formed animals by government services, without the intervention of butchers, to the local people at an attractive price, to increase the consumption of beef;

and medium to long term solutions:

- development of a marketing system which could sell the lean animals (young males and females) to Mauritian breeders who could fatten them with sugar cane by-products;
- development on Rodrigues of proper slaughterhouse facilities conforming to standard practices; such facilities would require investment in an industrial unit and the refrigeration equipment of the Mauritius Pride, so as to transport the meat to Mauritius.
- development of a beef butchering unit in conjunction with the abattoir to sell the poorly formed animals and the culled cows and to manufacture sausages and salami; a feasibility and marketing study should be made quickly to explore the relevance of such a facility.

Following a more thorough study, the chosen solutions will certainly take considerable time to put into effect. Hence it seems to be difficult to resolve the problem quickly, although this is essential, without state intervention. The problem lies in the social organisation of destocking. In order not to penalise the small producers who have only a few animals, the large breeders should really carry the heavier burden. Moreover it is with these large breeders that selection would be more effective, as they can be entrusted to look after quality breeding bulls which will then improve the herds, including those of the small breeders by transfer of quality heifers from the large to the small farmers. Also their small numbers allow quicker action by the public services. The large breeders (> 10 cows) who number less than 200 and own 1/3 of the island's herd, should therefore cull a large number of females (poorly-formed cows and heifers) in proportion to their herd size. The breeding bulls produced by the agricultural service's stations could then be exchanged for them, with a contract to prevent the bulls from being sold. The medium-sized breeders (with 5-10 cows), who number about 400 and also own about 1/3 of the herd, should also be involved but to a lesser degree, since the compensation is more difficult to organise. (Should a bull be made available to a group of breeders?) The very numerous small breeders (nearly 1500) with fewer than 5 animals should be encouraged to bring their animals voluntarily, possibly with the help of inducements.

Reorganisation of breeders, marketing and meat processing

It is very clear that many of the problems which Rodrigues has with its cattle herd stem from marketing difficulties. These can arise from two factors: the outlets and the organisation of the market. As regards the first point, efforts could be made to establish a recognised trade mark for the island of Rodrigues, an idea already put forward by Mandret and Roederer (1993). However this assumes that the Rodriguan producers are capable of producing quality meat (hence the need to improve rearing systems - see next para.) and that the second factor, i.e. the organisation of the market, is solved.

Currently the market is too dependent on the butchers, which makes it difficult to create reliable outlets, since they buy very selectively from the herd. They are not interested in the all of the products of the industry, and this is why the Rodriguan producers encounter problems. To change this system of marketing, it would be useful for the government services to encourage action by the breeders' co-operatives. In fact at present these are only concerned with supplies, such as feedstuffs and veterinary products. Under the aegis of FACER, the emergence of a "Rodriguan meat" co-operative (Mandret and Roederer, 1993) could prove to be a worthwhile approach to better market organisation, making it transparent and reliable over the long term. However this assumes that the producers would support this approach. Inducements in the form of genetic improvements, dipping, growth measurements, transport subsidies etc., are therefore to be promoted for those breeders wishing to form producers' groups. Around the "meat co-operative" several other producer groups should be formed for cattle, sheep and goats, and pigs. These need to be long-term measures to thwart the selective buying methods of the butchers. The industrial facilities which might possibly be set up by the State services, namely an abattoir, refrigeration rooms and processing plants, could be run by the co-operative, given additional training programmes.

Improvement of cattle husbandry systems

In parallel with this effort towards destocking, numerous steps should be taken to improve rearing standards. It is necessary to consider all these steps as a whole: genetic improvement, identification of animals, monitoring of performance and health status.

One priority, given the great variability of the animals and the market requirements, is without doubt genetic improvement. Work has already begun at the different breeding stations of the agricultural services. However it seems that the distribution of the genetic material is not effective. It will be necessary to increase production of quality male breeding stock, with better carcass weight and conformation, from females selected on the island for their qualities (weight, conformation, calving record, maternal characteristics) inseminated by approved bulls (for example American Brahman). The females resulting from these crosses would be suitable to increase and renew the herds on the selection farms and the males could quickly be made available to the breeders, especially the largest of them, so that they can continue the selection on their own herds. They in turn could sell quality heifers to smaller breeders and quite soon profit from the males which are more easily sold to butchers.

Of course this selection effort can only bear fruit over several years. It therefore assumes that all the animals are identified by tagging at birth and followed through to slaughter by computer coding. Apparently the tools to do this already exist. According to De Schrevel (1996), there may still be a problem in the means of implementation. We did not manage to check this during the visit. Furthermore, to guarantee the efficacy of this genetic improvement with the breeders, performance monitoring, in the form of regular weighing, should be put in place, firstly on the agricultural services' stations (if this is not already happening) and later among groups of breeders.

To facilitate identification, it would be useful to construct small restraining equipment, managed by groups of breeders, for applying anti-parasitic treatments. This equipment would assist veterinary operations and could encourage the breeders (by way of free treatment) and would later on allow the organisation of performance monitoring. It is clear that efforts to improve the herd will soon be wasted unless they are accompanied by a health programme.

Improvement of forage production

Numerous forage species are present on Rodrigues. In fact, as a result of the recommendations of Mandret and Roederer (1993), introductions have been made. We will not deal with the species used, as that is outside our own competence and it seems that the report by Mandret and Roederer (1993) represents a fairly exhaustive list of possibilities as regards choice of species on the island, categorised according to their soil and climatic requirements. During the visit we were able to confirm that the agricultural services have a wide range of plant material which is beginning to be distributed to farmers.

To protect the forage resources, woodland pasture areas have been created. There again Mandret and Roederer's report (1993) explains the relationship between sylviculture and forage production. However, as these authors pointed out, we noticed during our visit that these woodland pastures are under-utilised. In fact they are only cut once a year in the dry season if the breeders are short of grass. This has the consequences (i) of a resource being unused for much of the year, with the risk that the pasture may be deteriorated, (ii) a decline in the digestibility of the forage, (iii) a serious risk of fire from the dry grass. The reasons given by the breeders are the problem of transporting the forage and the amount of work involved. Considering the method of production, it seems to us that these woodland pastures should be grazed regularly while controlling the stocking rate and duration. This could be done by a local association which might collect a grazing fee to pay for the work of looking after the reserve. However, the last grazing must take place at the end of the rainy season (April-May) in order to allow four months of regrowth so as to leave a standing sward sufficient for the October dry season. It would also be advisable to take steps to protect the young trees.

Mandret and Roederer (1993) suggested a scheme which combined woody hedgerows and grasses to restore and protect the terraces. We can only agree with this, but would advocate the use of fodder producing hedges, rather than just wind-breaks or anti-erosion barriers, to provide extra scope for fattening, especially in the higher regions (> 150 m) which have good agricultural potential. It is not certain whether vetiver which is a very valuable plant for erosion control, would be a wise choice for general distribution in a situation where there is a shortage of forage. As animals graze it with great difficulty, it would be preferable to confine it to banks and the margins of roads etc to provide permanent protection.

Based on this earlier work which is a good guide to the possibilities for forage improvement on the island, we can list proposals for action for the 11 units which we defined earlier on (table 2); a more precise mapping of these zones would be necessary to guide the required work.

***Table 2**: possible improvements in forage production systems in the different zones*

No.	type	altitude	forage	livestock	changes to implement
1	stony "cattle walk"	0-100	Open pasture	Sheep	Low stocking rate
2	chalky "cattle walk"	0-50	Open pasture	Sheep and goats	Low stocking rate
3	fertile "cattle walk"	0-50	Fenced meadows and hay	Suckling cows	Large paddocks (5-10 ha) Adjust rate to paddock size Record stock arrivals and departures Construct spray-pens Haymaking trials
4	Sloping terraced plateaux	<150	Fenced meadows	Suckling cows	Medium-sized paddocks (1-5 ha) Adjust rate to paddock size Record stock arrivals and departures Construct spray-pens
5	Terraced upper valleys	>150	Fenced meadows + hay + fodder hedges	Suckling cows + fattening cattle + goats	Small paddocks (0.5-1 ha) Adjust rate to paddock size Record stock arrivals and departures Construct spray-pens Restore terraces Haymaking trials Cowsheds for manure
6	Crater bottoms	>200	Fenced meadows + fodder hedges	Fattening cattle + goats	Small paddocks (1-2 ha) Adjust rate to paddock size Record arrivals and departures of stock Restore terraces Cowsheds for manure
7	Irrigated valley bottoms	0-20	Fodder hedges + crop residues	Fattening cattle + goats + pigs	Cowsheds for manure Pigsties Pens
8	Cultivated areas	Every-where	Fodder hedges + crop residues	Fattening cattle + goats + pigs	Cowsheds for manure Pigsties Pens Restore terraces
9	Housing areas (highland)	>200	Fodder hedges	Goats and pigs	Closed housing of animals
10	Forest (woodland pasture)	Depends on forage production	Hay and controlled grazing	Fattening cattle or sheep	Small paddocks (1-2 ha) Protect young trees Cowsheds nearby
11	Steep slopes	Every-where	Open pasture	Sheep	Very low stocking Plant protected forest

In general, there being insufficient forage, the cattle herds should be separated from the sheep. When fodder is short, the cattle graze all the regrowth quite closely, without any real selection, and tend to pull out tufts of grass; the sheep then have a disastrous complementary action as they select the remaining herbage to ground level. This is very bad for the legumes, which should not be grazed below the collar, and for the grasses which then take a long time to regrow. Furthermore, within the cattle herds, the fattening animals should be separated from the breeding animals which are weaning lightweight calves. Such separation enable the needs of the herds to be better matched to the forage potential of the various zones. This kind of herd management is less important for goats which are often looked after in small groups. They could however be better utilised in conjunction with the fodder shrubs planted in the anti-erosion hedges.

Moreover, the relationship between agriculture and animal husbandry should be permanently restored, especially in the cropped terraced areas in the highlands, which have good agronomic potential. A good way of doing this would be to plant hedges which protect the soil and guarantee quality forage for livestock. In return, the animals, if properly housed (which means building cowsheds to collect manure) provide the organic matter needed for good crop growth.

Concerning husbandry methods, grazing is practised in the same way throughout the island and threatens this agriculture/livestock relationship. Other practices should therefore be developed such as zero-grazing, in which the animals are permanently housed; this is most suitable for fattening animals. Also, considering the amount of forage which could be grown in the wet season, it should be possible, provided the stocking rate is reduced, to conserve forage in the wet season for use in the dry season. First of all, haymaking should be tried in various regions. A study by the meteorological services of the frequency of periods of days without rain (2, 3 or 4 successive days) in the rainy season would enable the agricultural services to assess the risks to haymaking in the chosen areas. Depending on whether this proves feasible, choosing suitable species, such as *Chloris gayana*, and the development of mechanisation, such as mowing, hay drying, windrowing and baling, could be considered. However, such mechanised operations would first require stone clearance and field levelling (as done for 20 years in La Réunion by the Union of pastoral land associations). The technique of ensilage in plastic-wrapped bales could be an alternative where conditions are unsuitable for haymaking, i.e. where two successive rainless days cannot be expected. However it would still be necessary to de-stone and level the meadows and to supplement the haymaking system by using a bale-wrapping machine which stretches cling-film round the bale, and to add molasses to the forage to guarantee good fermentation if the dry matter content at harvest is below 40%. (Tropical forages are too low in soluble carbohydrates to be ensiled without additives). These conditions and the costs involved would make this latter technique difficult to implement on Rodrigues. If forage conservation is to be practised on Rodrigues, we suggest the following steps: (i) feasibility study, (ii) pasture improvement, (iii) mechanisation of haymaking, (iv) perfecting of techniques.

Extension and training

Animal rearing is the main form of agricultural production on the island and is subject to many problems. However, as far as we know, there are few training officers in this field. It would thus be wise to reinforce the agricultural services with more animal husbandry expertise; the recent appointment of an entomological technician to the livestock service does not seem very well thought out; whereas this expertise could be valuable to fruit production, which is being developed (Bertin and Courchinoux, 1991), and has problems with fruit fly.

If Rodrigues wants to improve its husbandry systems to increase productivity but with less harm to the environment, there is much to be done by the animal husbandry training services, as production is at present so fragmented. In our view, two levels of activity should be given priority to improve extension and training:

- at the general level: genetic improvement, animal identification, forage trials (species, harvesting techniques), data collection in each region,
- at the local level: prophylaxis, performance monitoring, animal housing, water management, pasture management.

The first of these could be the responsibility of the agricultural services by supporting the co-operatives and other groups. The second level is a matter for local action by the authorities with the support of the co-operatives and agricultural services.

At present, the officials in charge of livestock breeding are preoccupied by destocking problems. The task is not easy and it seems desirable to involve the co-operatives more in the work and that in due course they should become the main organisers of the meat market. In this way the employees of the agricultural services could be freed to give advice to breeders on husbandry techniques to be promoted on the island. At the same time, the island desperately lacks the means for monitoring breeding (reproduction, mortality, growth) and data (forage production, breeding performance) to guide agricultural policy. An R & D unit should be set up for this within the agricultural service. This unit could work together with groups in La Réunion (CIRAD and development partners) where such monitoring/data acquisition schemes are already established. One is bound to recommend exchanges between the two islands. The novel approach to watershed management which started in Rodrigues would be of interest in La Réunion.

Proposals for localised actions as part of the project

The recommendations made above are of general importance to the island, since the overgrazing problem is found almost everywhere on Rodrigues. Action should therefore be taken at the highest level, i.e. by the main administration of the island (Island Secretary, agricultural services) which, as has been suggested, could devolve its authority and powers to co-operatives and producers' groups.
However, other actions, although taking place within the overall plan, should be taken at the village level, in a collaborative approach with the villagers (Angé, 1999a). This approach is the one preferred in the "Erosion control in Rodrigues" project.

Approach by village communities

Several communities will be involved in the catchment areas proposed for development. Involvement at this level is fundamental to managing so many activities in a given region. A contract should be drawn up between the Erosion Control Project and these communities to implement the communal arrangements needed to satisfy the inhabitants' requirements in terms of water, forage resources, terraces for farming etc.

Unlike the present situation in which rearing, especially of cattle, dominates the whole country without any precise rules (grazing rights), in the contract, breeding will have to adapt to regulations which ensure that all the inhabitants have access to the new resources created by the redevelopment. In particular, free ranging of animals will no longer fit in with the good resource management for which each community will be responsible. Each village community will have to make individual and collective management rules for all the land under its control.

Water management for livestock

Water in Rodrigues is scarce for all purposes. In particular there is competition between drinking water for the population and water for agriculture. In the project it is planned to make this resource more secure by constructing water collection points and small dams for agricultural use. Rearing is therefore very much involved in these developments, but competes with crop irrigation. Arrangements will be needed within communities for sharing these reserves. Even so, if the potable water is to be reserved for human consumption, it will undoubtedly be necessary to put "agricultural" water consumption by animals before crop irrigation, while first ensuring a reduction in the size of the herds.

Creation and management of communal pastures

To prevent free ranging by cattle, paddocks should be created and fenced. We suggest that these paddocks should be of a size which matches the forage growth potential of the area (small paddocks in the highland areas, large paddocks in the "cattle walks") and the aspirations of the breeders in the community. In fact, given the small size of the herds and the leases currently granted (0.25 - 1 ha) it is not possible to allocate and fence a paddock for each farmer. The management of the paddocks will therefore have to be communal. Within communities, it would be necessary to create small groups of breeders (maximum 4-5), based on families or friendships, each in charge of a communal paddock used for continuous grazing which is easier to manage than rotational grazing. General rules of good management, regarding type of animal, maximum stocking rate per paddock according to season, herbage height at entry end exit of stock, could be made by the whole community with the technical help of the agricultural services. A water supply should be laid on to avoid excessive animal movement.

In addition to these paddocks where grazing would be allowed, restoration of the terraces could be planned to produce forage for fattening animals by zero grazing, and to suckling animals in dry periods (standing reserves growing on the edges of terraces). This type of forage production (hayfields plus fodder hedges) could also be managed individually, like the crops, so long as leases are available.

Construction of paddocks and animal shelters

Further, if free ranging of animals is to be prohibited, the breeders (especially those involved in fattening) must be given the means, i.e. authorisation, loans, subsidies, to construct sheds, even if quite rudimentary, in which to shelter, feed and water their animals, and from which to collect the manure produced for the crops or forage grown on the terraces. The project financing does not provide for this kind of individual investment. It is therefore important that the State services should take responsibility for such involvement to encourage a more rational type of husbandry. Rules for animal movements should be made and routes marked out for driving animals each day between pastures and shelters. Communal spray-pens for parasite control could be constructed if the breeders agree to adopt more environmentally-friendly practices, such as reduced stocking rates and acceptance of areas where grazing is prohibited.

The move towards provision of shelter applies to all kinds of animal (cattle, sheep, goats and pigs). In fact we have noticed soil and pasture damage near houses caused by tethered pigs.

It is also possible that the village communities might become agents for the co-operatives and agricultural services for the purposes of genetic improvement, (selected bulls could be made available to breeders' groups), performance monitoring, prophylaxis and perhaps the development of customer loyalty as part of the marketing operation, if the co-operatives decide to follow this route. Organisation at the local level, if assisted by enough training managed by the island government, could thus lead to improvement in Rodriguan livestock husbandry.

Harvest and conservation of forage

With the present state of techniques in Rodrigues, haymaking can only be envisaged as a manual operation on small plots on managed terraces. In view of the weather during the grass growing season, it is probably not possible in every region.

In their search for appropriate methods of forage conservation on Rodrigues, the agricultural services could benefit from the help of village communities by making hay, on an experimental basis, which the breeders from these communities could feed to their animals. Some simple arrangement would be needed to store the hay, such as tarpaulins held to the ground by netting so as to provide protection from the strong winds (cf the experience of Sica-lait on La Réunion).

As to the development of these techniques, stock rearing at present requires very little investment of labour by the breeders. The change in pasture management method to fenced paddocks or feeding in sheds could already present problems of labour availability. The forage harvest (manual for the time being) for conservation will also increase the labour demand. One may wonder whether livestock rearing would still seem as profitable in the breeders' eyes. However, given the over-stocking situation, persuading or obliging the breeders to invest more in their production in terms of labour, inputs, rearing infrastructure, would surely help to make them more professional whilst reducing the emphasis on the value of stock as "capital on the hoof". Furthermore, on an island where there is very high unemployment, livestock rearing, if sufficiently profitable (and here there is a problem in establishing a loyal market) can be an important source of employment, e.g. for feeding, harvesting hay, herding and monitoring herds. Within the village communities, it will be important to introduce training, based on the husbandry practices to be used.

Conclusion

To carry out the Rodrigues Erosion Control project properly it is clear that husbandry should be planned so as to reduce the grazing pressure. In fact, too high a pressure on forage resources in the dry season leads to overgrazing, resulting in bare soil which gets washed right down to the lagoon by the rain which is often very heavy following the dry season.

Our investigations show that the potential forage production of the island is enough to feed a maximum of 7000 TAUs, whereas at present the number is more than 10,000 TAUs. The cattle are the animals mostly concerned. Destocking, which has already begun, should be intensified to quickly reach 4000 cows. Drastic culling of females should be practised for four years to return to the correct balance. This programme would provide the opportunity to select among the female herd (cows and heifers). In fact it seems that the main problem for the market is to supply well formed, heavy male animals. Selection should enable this objective to be reached progressively and to stabilise this market. However, after the four years, female culling should continue at a normal level to maintain the herd in balance. It is thus important to seek a permanent outlet for the culled females, such as processing, sale as lean cows etc) without which the industry risks eventual collapse.

In the longer term, it is possible to improve husbandry practices to respond to the double objective of greater profitability of the products and concern for the environment (preservation of forage resources). An effort towards genetic improvement, identification of animals and disease prevention should be considered. Techniques such as planned grazing (enclosures) and making use of fodder hedges are possible. Forage conservation, particularly as hay, should also be considered, but this assumes much more investment in materials and labour which may not fit in with the breeders' objectives.

The general approach to these husbandry problems adopted by the agricultural services and the breeders' co-operatives should be passed on to the local level. The village communities which will be responsible for managing the catchment areas envisaged in the project are an ideal vehicle for promoting new ways of rearing the cattle. The approach include participation, bringing together the experience of the local breeders, whilst taking account of their objectives and their practices to arrive at co-ordinated management of the community's land. These local experiments will be very useful to the State services in persuading the Rodriguan breeders to adopt a more stable system.

Programme for the visit

Tuesday 26 October 13.30: depart La Réunion by flight MK 231.

Tuesday 26 October 18.10: arrive Rodrigues flight MK 140; staying at Port Mathurin.

Wednesday 27 October: meet agricultural services and farmers' associations (Tambes, Anse Mourouk); visit farms; visit southern regions (Mount Lubin as far as Anse Mourouk).

Thursday 28 October, morning: with Miss J.Allas and Mr. G. Bouman; visit forage plots of the agricultural services; visit central and western regions (St. Gabriel, Citron Donis, La Ferme, Mount Croupier and the Marpou plain).

Thursday 28 October afternoon: meet the Island Secretary; visit the north coast (Port Mathurin to Baie du Nord and return via les Hauts, then Port Mathurin to Grande Baie) with Mr. Bouman.

Friday 29 October, morning: visit animal embarkation point at Port Mathurin; meeting with Miss J. Allas and Mr. Leong Tim; meeting with all the State service departmental heads at Citronelle.

Friday 29 October, afternoon: office work, writing up and summarising agricultural statistics on livestock husbandry.

Saturday 30 October, morning: office work, analysing statistics, reviewing literature.

Saturday 30 October, afternoon: visit to southern regions (Mangue, Baie Pistache, La Ferme, Caverne plain, Petite Butte, Rivière Coco, Port Sud-Est, returning via Mount Lubin).

Sunday 31 October, morning: office work, developing a model for predicting livestock rearing effects; meeting with farmers from Anse Mourouk; visit to the irrigated area.

Sunday 31 October, afternoon: visit to the eastern plateau (Grande Montagne, new discovery [???], Saponaire, Mount Cabri).

Monday 1 November, morning: office work, predictive model; visit to the northern/northeast plateau (Dans Bébé, Mount Goyave, Brûlé, Roche Bon Dieu, Pointe Coton).

Monday 1 November, afternoon: free.

Tuesday 2 November: meeting with Dr Jaumally Reshad, veterinary surgeon, Mr. Leong Tim and Miss Allas at Citronelle.

Tuesday 2 November, afternoon: office work, finishing literature review; model simulations; starting report on visit.

Wednesday 3 November, morning: meeting with Messrs Wenceslas, Felicité, Prudence Jo from the Federation of Co-operative Associations of Rodriguan Breeders (FACER) and Miss Allas at Citronelle.

Wednesday 3 November, afternoon: preparing for workshop on Thursday 4/11 and writing report of visit.

Thursday 4 November: workshop with the Island Secretary, State Department Heads, specialists and farmers' groups to finalise the project.

Friday 5 November 09.50: Depart Rodrigues flight MK 121.

Friday 5 November 19.00: arrive La Réunion by flight UU 109.

People met

The Island Secretary

Mr Leong Tim, Scientific Director of agricultural services, National Director of the project.

Miss Allas, Rearing systems specialist.

Mr J W Tobize, Agricultural development specialist.

Dr Jaumally Reshad, veterinary surgeon.

Mr Wenceslas, President of FACER (Federation of Co-operative Associations of Rodriguan Breeders) and President of ACFPR (Co-operative Association of Rodriguan Farmers and Producers).

Mr Felicité, Secretary of ACEM (Co-operative Association of Maréchal Breeders).

Mr Prudence Jo, President of ACEOR (Co-operative Association of Breeders of Western Rodrigues).

Groups of farmers and breeders from Tambes and Anse Mourouk.

Mr. Bouman, Chief of the project.

Mr. Tilman, mission leader.

Mr. Angé, member of the mission.

Mr. Castagnet, surveyor, member of the mission.

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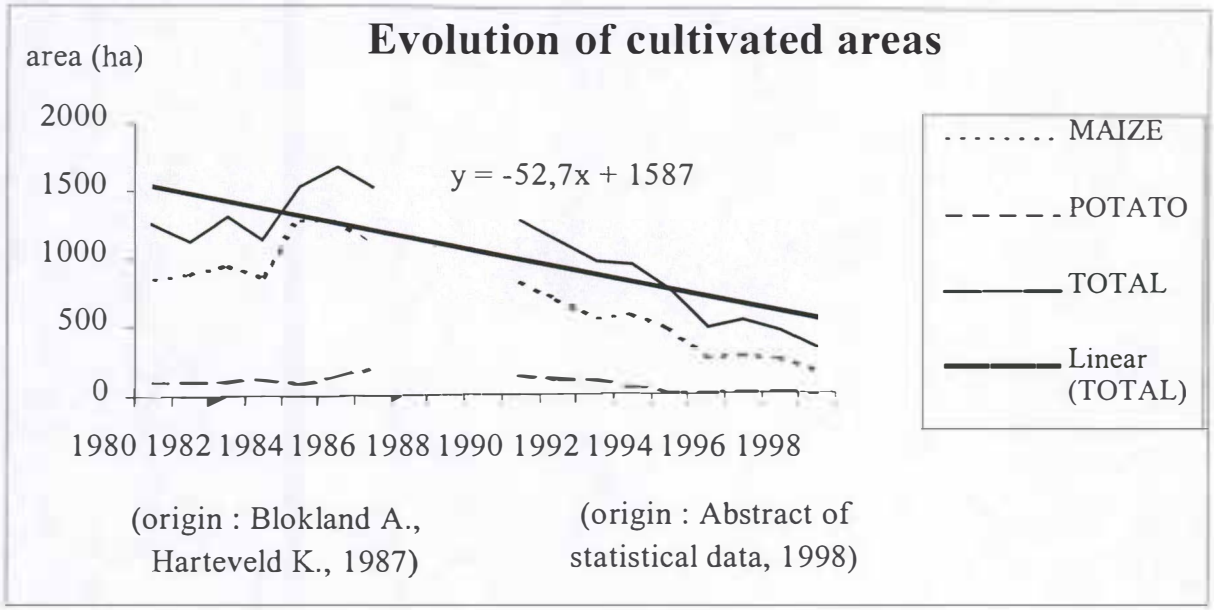
Annexes

Annexe 1 : terms of references from Vakakis International

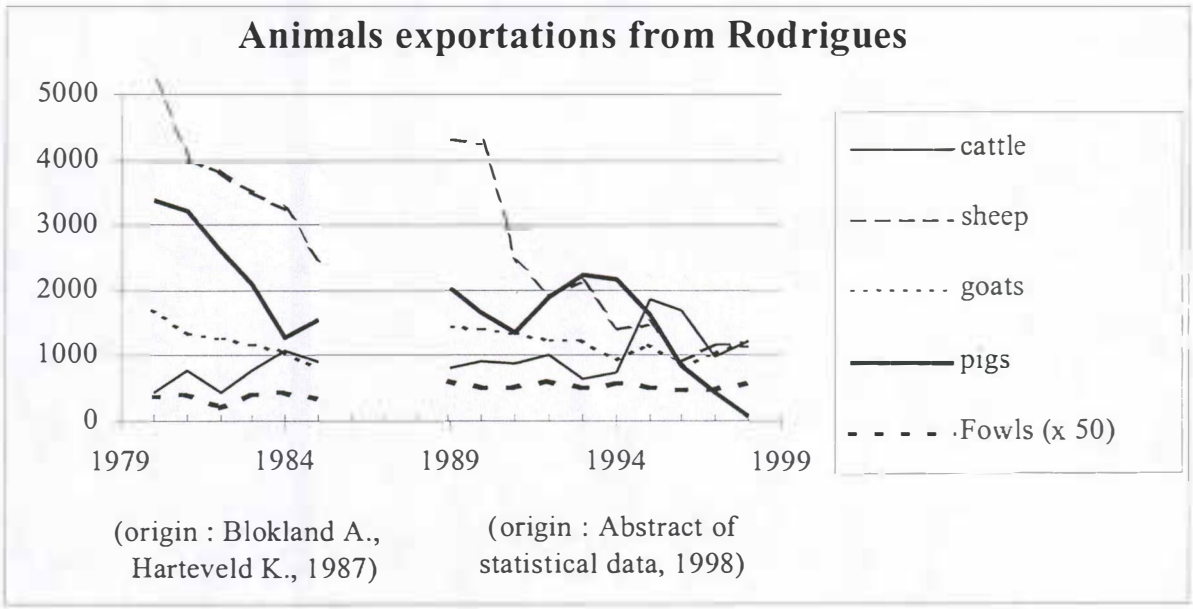
A 2-week input to Rodrigues Island's Anti-Erosion Programme, as an initial mission, reporting to the Project Director/Co-Director, Project Manager, the Project Co-Regisseur and to the Island Secretary of Rodrigues. PMU's head quarter based in Citronelle, Georg Bouman (Project Manager), Rodrigues, Republic of Mauritius. The general framework of the expert's ToR is presented below. It is understood that the areas not fully covered in this first introductory mission, will be covered in the sequential missions.

- Rapid review of the animal production patterns in the island and existing market status.
- Assessment of materials and equipment needed for the livestock purposes of the Research and Development Unit.
- Institutional Strengthening and Development.
- Advise on the setting up of a livestock Research Unit within the R&D Unit (to be created).
- Assessment for training needs on livestock/pasture/de-stocking issues and elaborate training programmes for staff, counterparts breeder association members.
- Advise the PMU on global approach for de-stocking livestock number and better management of fodder about methodologies for producing more valuable animal products and for promoting labels on these products.
- Proposals to the Agricultural Services on livestock/pasture issues related to R&D, applied resarch, actions for development :
  - –Study the cost and benefit ratio of today's animal production habits and compare to an alternative modern ranching model, appropriate to an adequate Land Resource Management policy fulfilling the objectives of the Project Programme.
  - –Proposals for a Regional Ranching Management system which is in harmony with the environmental conditions, reducing number of animals per ha, improving registration, monitoring and control conditions.
  - –Proposals of an introduction to a Sylvi-pastoral Management system, improving plantation techniques, improvement of pasture and grassland conditions.
- Recommendations for strengthening the commercialisation of livestock to Mauritius.
- Contribution to the OWP drafting :
  - –Contribution to the elaboration of the overall logical framework with emphasis on livestock/pasture issues.
  - – Proposal to the OWP of a strategy in the Pilot Areas, for a specific de-stocking program in exchange of alternatives.
- At the end of mission, preparation of a report detailing the main accomplishments during the input as well as key recommendations for the future.
- Propose a timetable for Review Missions.

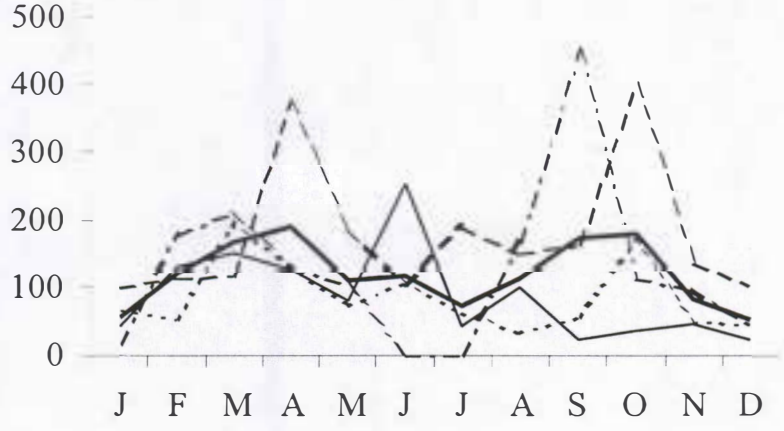
Annexe 2 : cultivated areas



Annexe 3 : animals exportations and slaughtering

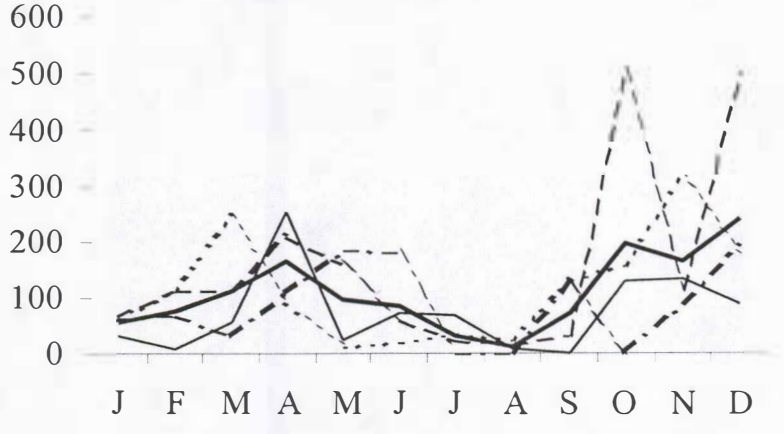


Monthly variation of cattle exportations



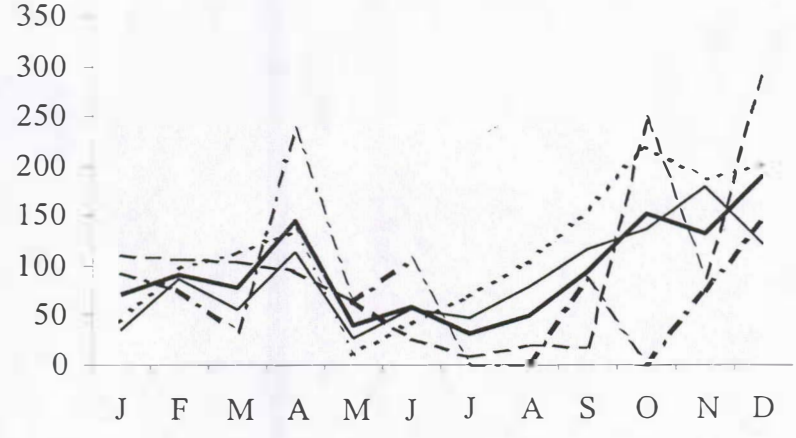
(origin : Agricultural services, 1999)

Monthly variation of sheep exportations



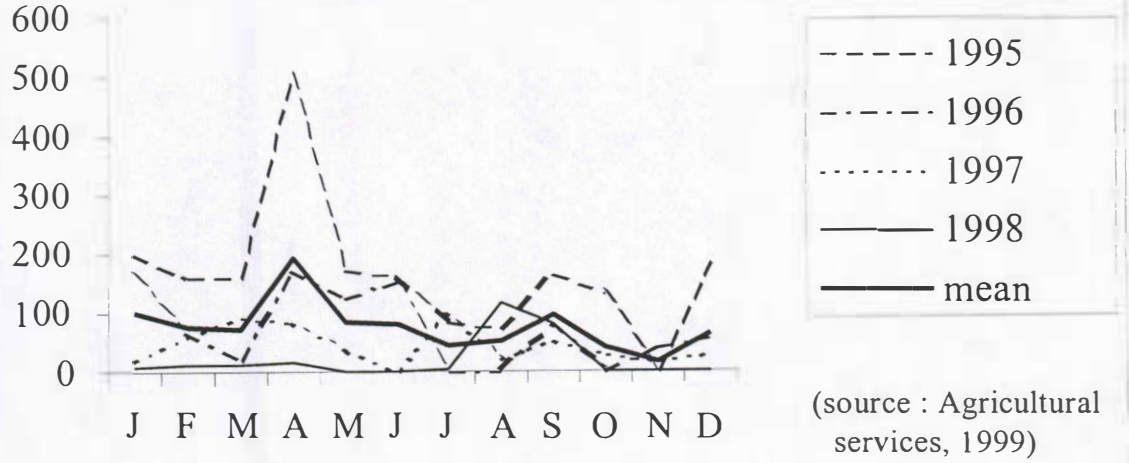
(source : Agricultural services, 1999)

Monthly variation of goats exportations



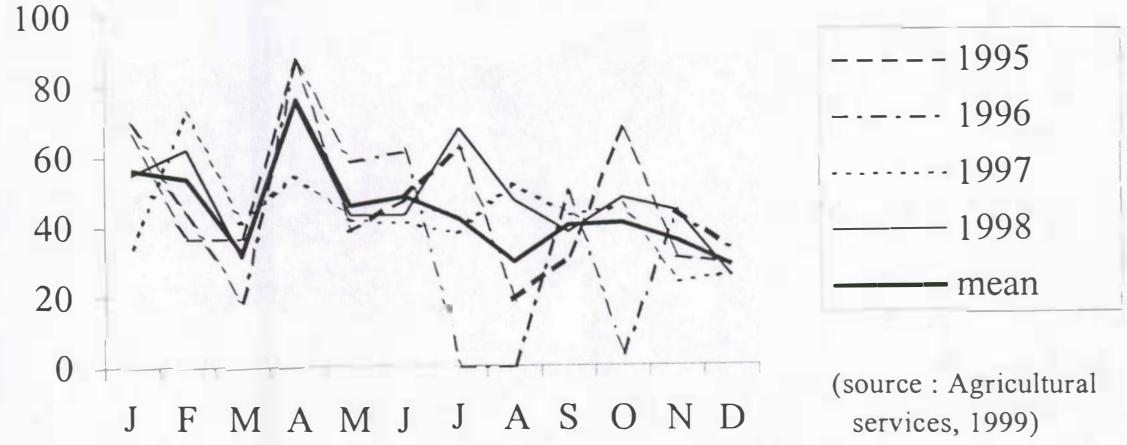
(source : Agricultural services, 1999)

Monthly variation of pigs exportations



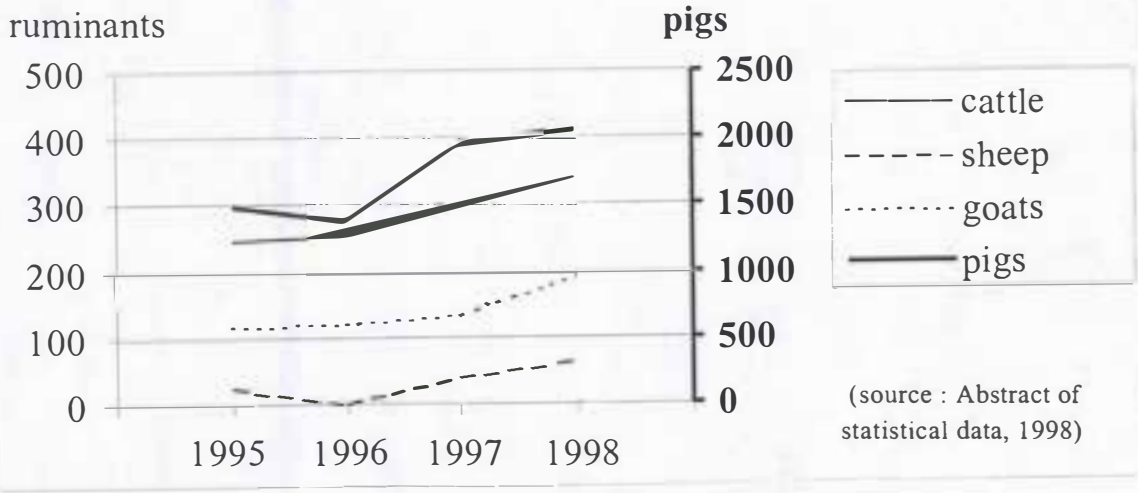
(source : Agricultural services, 1999)

Monthly variation of fowls exportations (x 50)



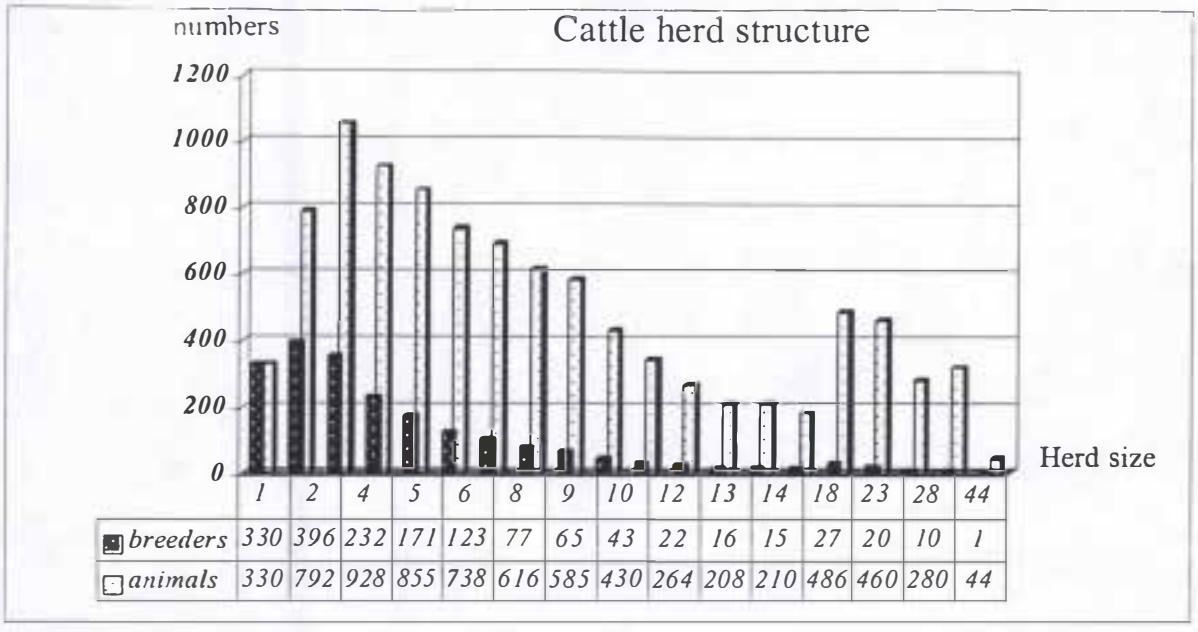
(source : Agricultural services, 1999)

Slaughtering evolution in Rodrigues



(source : Abstract of statistical data, 1998)

Annexe 4 : number and size of cattle breeding



	1	2	4	5	6	8	9	10	12	13	14	18	23	28	44
breeders	330	396	232	171	123	77	65	43	22	16	15	27	20	10	1
animals	330	792	928	855	738	616	585	430	264	208	210	486	460	280	44

(origin : De Schrevel, 1996)

Annexe 5 : females productivity (number of calving)

Mean	Number of calving per cow										Total
age	0	1	2	3	4	5	6	7	8	9	
3,5	515	302									817
4,5	172	489	213	3							877
5,5	37	297	558	117	4						1013
6,5	5	64	156	410	79	1					715
7,5	0	4	30	95	148	38	1				316
8,5	1	2	6	17	53	93	9	1			182
9,5	2	0	6	9	13	22	48	34	16	16	166
total	732	1158	969	651	297	154	58	35	16	16	4086

(source : De Schrevel, 1996)

Annexe 6 : estimation of forage potential, area and animal stocking

N°	type	Altitude (m)	Potential (t DM / ha / yr)		Area (mean ± 20%) (ha)			Production (t DM / yr)			Animal stocking (TAU)		
			min	max	min	max	mean	min	max	mean	min	max	mean
1	Stony "cattle walk"	0-100	0,5	1	1312	1968	1640	656	1968	1230	219	656	410
2	"cattle walk" on chalk	0-50	1	2	448	672	560	448	1344	840	149	448	280
3	Fertile "cattle walk"	0-50	2	3	448	672	560	896	2016	1400	299	672	467
4	Sloping terraced basaltic plateaux	< 200	3	4	784	1176	980	2352	4704	3430	784	1568	1143
5	Terraced upper valley regions	> 200	5	6	288	432	360	1440	2592	1980	480	864	660
6	Crater bottom	> 200	10	12	336	504	720	3360	6048	7920	1120	2016	2640
7	Irrigated valley bottoms	0-20	12	15	240	360	300	2880	5400	4050	960	1800	1350
8	Cultivated areas	everywhere	0	2	320	480	400	0	960	400	0	320	133
9	Housing areas (upper areas)	> 200	0	2	240	360	300	0	720	300	0	240	100
10	Forest	everywhere	0	0,5	1280	1920	1600	0	960	400	0	320	133
11	Steep slopes	everywhere	0	0,5	5104	2256	3380	0	1128	845	0	376	282
	Utilised agricultural area				4176	6264	5520	12032	25032	21250	4011	8344	7083
	Total area				10800	10800	10800	12032	27840	22795	4011	9280	7598

Annexe 7 : simulation model of numbers and culling evolution

(next 2 pages)

SIMULATION WITH PRESSURE ON FEMALES CULLING

females	ef 1995	tx ref.	Ref.	ef 1996	tx ref.	Ref.	ef 199	tx ref.	Ref.	ef 1998	tx ref.	Ref.	ef 199	tx ref.	Ref.	ef 200	tx ref.	Ref.	ef 200	tx ref.	Ref.	ef 200	tx ref.	Ref.	ef 200	tx ref.	Ref.	ef 200	tx ref.	Ref.	ef 2005	tx ref.	Ref.	ef 2006	tx ref.	Ref.	ef 2007	tx ref.	Ref.	ef 200	tx ref.	Ref.	ef 200	tx ref.	Ref.	ef 2010
>9 ans	167	0,9	150	52	0,9	47	23	0,3	7	101	0,3	30	289	0,33	95	404	0,8	323	164	0,8	131	87	0,8	69	48	0,8	39	32	0,9	29	27	0,9	24	16	0,9	15	14	0,9	13	13	0,9	12	25	0,9	22	22
8 à 9	182	0,6	146	93	0,6	74	124	0,3	37	320	0,3	96	326	0,33	106	269	0,7	202	186	0,7	130	107	0,7	75	78	0,7	55	80	0,7	56	48	0,7	32	44	0,7	31	41	0,7	29	79	0,7	56	67	0,7	47	57
7 à 8	316	0,7	221	420	0,7	294	467	0,3	140	475	0,3	143	439	0,33	145	473	0,8	284	273	0,8	164	199	0,8	119	204	0,6	122	158	0,7	110	148	0,7	104	139	0,7	97	270	0,7	189	227	0,7	159	194	0,7	136	226
6 à 7	715	0,4	286	794	0,4	318	806	0,2	121	561	0,2	112	619	0,22	136	558	0,5	279	406	0,5	203	416	0,5	208	322	0,5	161	252	0,4	101	238	0,4	94	459	0,4	184	385	0,4	154	331	0,4	132	385	0,4	154	345
5 à 6	1013	0,2	203	774	0,2	155	636	0,1	64	702	0,1	70	639	0,11	70	690	0,4	276	707	0,4	283	547	0,4	219	429	0,4	171	301	0,2	60	585	0,2	117	492	0,2	98	422	0,2	84	491	0,2	98	440	0,2	88	445
4 à 5	877	0,1	88	721	0,1	72	796	0,1	80	725	0,1	73	791	0,11	87	1031	0,3	309	797	0,3	239	625	0,3	187	439	0,3	132	664	0,1	86	557	0,1	56	476	0,1	48	557	0,1	56	499	0,1	50	504	0,1	50	532
3 à 4	817	0,1	82	902	0,1	90	779	0,05	39	850	0,05	42	1114	0,055	61	1017	0,2	203	797	0,2	159	560	0,2	112	847	0,2	169	632	0,1	63	542	0,1	54	631	0,1	63	565	0,1	57	572	0,1	57	603	0,1	60	602
2 à 3	1023	0,1	102	883	0,1	88	867	0	0	1136	0	0	1038	0	0	1017	0,2	203	715	0,2	143	1080	0,2	216	606	0,2	161	615	0,1	61	716	0,1	72	641	0,1	64	648	0,1	65	663	0,1	68	682	0,1	68	669
1 à 2	901	0	0	885	0	0	1159	0	0	1059	0	0	1153	0,1	115	911	0,2	182	1377	0,2	275	1028	0,2	206	784	0,2	157	731	0	0	654	0	0	661	0	0	697	0	0	696	0	0	683	0	0	685
< 1	903	0	0	1183	0	0	1061	0	0	1176	0	0	1329	0,3	399	1405	0	0	1049	0	0	800	0	0	745	0	0	667	0	0	675	0	0	712	0	0	710	0	0	697	0	0	699	0	0	702
cows (>4)	3270	0,33	1093	2854	0,34	960	2652	0,17	449	2884	0,18	524	3104	0,21	842	3445	0,49	1673	2533	0,45	1150	1981	0,44	878	1520	0,45	680	1487	0,28	423	1600	0,27	427	1628	0,29	472	1689	0,31	525	1640	0,31	507	1615	0,31	497	1627
heifers	3644	0,05	184	3853	0,05	179	3886	0,01	39	4221	0,01	42	4633	0,12	575	4351	0,14	589	3938	0,15	576	3489	0,15	534	3182	0,15	487	2845	0,05	125	2567	0,05	128	2645	0,05	127	2621	0,05	121	2648	0,05	128	2668	0,05	128	2657
bulls	ef 1995	tx ref.	Ref.	ef 1996	tx ref.	Ref.	ef 199	tx ref.	Ref.	ef 1998	tx ref.	Ref.	ef 199	tx ref.	Ref.	ef 200	tx ref.	Ref.	ef 200	tx ref.	Ref.	ef 200	tx ref.	Ref.	ef 200	tx ref.	Ref.	ef 200	tx ref.	Ref.	ef 2005	tx ref.	Ref.	ef 2006	tx ref.	Ref.	ef 2007	tx ref.	Ref.	ef 200	tx ref.	Ref.	ef 200	tx ref.	Ref.	ef 2010
>9 ans	1	0,7	1	1	0,7	0	0	0,7	0	0	0,7	0	1	0,77	1	1	0,7	1	2	0,7	1	2	0,7	1	2	0,7	1	2	0,7	1	2	0,7	1	2	0,7	1	2	0,7	2	2	0,7	1	3	0,7	2	2
8 à 9	1	0,7	1	1	0,7	1	1	0,7	1	2	0,7	2	4	0,77	3	5	0,7	4	4	0,7	3	4	0,7	3	4	0,7	3	5	0,7	3	4	0,7	3	8	0,7	4	5	0,7	3	7	0,7	5	5	0,7	4	4
7 à 8	2	0,5	1	2	0,5	1	4	0,5	2	8	0,5	4	12	0,55	7	8	0,5	4	9	0,5	4	7	0,5	4	9	0,5	5	8	0,5	4	12	0,5	8	9	0,5	5	14	0,5	7	11	0,5	5	8	0,5	4	8
6 à 7	4	0,4	2	6	0,4	3	14	0,4	5	20	0,4	8	15	0,44	7	14	0,4	6	13	0,4	5	18	0,4	6	14	0,4	6	20	0,4	8	16	0,4	8	24	0,4	10	18	0,4	7	14	0,4	6	13	0,4	5	11
5 à 6	13	0,4	5	23	0,4	9	34	0,4	14	28	0,4	10	26	0,44	12	21	0,4	9	27	0,4	11	24	0,4	10	34	0,4	14	27	0,4	11	41	0,4	16	31	0,4	12	23	0,4	9	22	0,4	9	20	0,4	8	20
4 à 5	59	0,6	35	88	0,6	53	67	0,6	40	67	0,6	40	84	0,66	42	68	0,6	41	62	0,6	37	87	0,6	52	69	0,6	42	105	0,6	63	78	0,6	47	80	0,6	36	56	0,6	33	50	0,6	30	50	0,6	30	53
3 à 4	299	0,7	209	227	0,7	159	229	0,7	160	219	0,7	153	301	0,77	232	211	0,7	147	296	0,7	207	236	0,7	165	357	0,7	250	267	0,7	187	203	0,7	142	189	0,7	133	170	0,7	119	172	0,7	120	181	0,7	127	180
2 à 3	772	0,7	540	780	0,7	546	743	0,7	520	1023	0,7	716	934	0,77	719	1005	0,7	704	804	0,7	563	1215	0,7	850	907	0,7	635	692	0,7	484	644	0,7	451	577	0,7	404	583	0,7	408	615	0,7	431	614	0,7	430	602
1 à 2	884	0,1	88	843	0,1	84	1159	0,1	116	1059	0,1	106	1153	0,11	127	911	0,1	91	1377	0,1	138	1028	0,1	103	784	0,1	78	731	0,1	73	654	0,1	65	661	0,1	66	697	0,1	70	696	0,1	70	683	0,1	68	685
< 1	860	0	0	1183	0	0	1081	0	0	1176	0	0	1329	0,3	399	1405	0	0	1049	0	0	800	0	0	745	0	0	667	0	0	675	0	0	712	0	0	710	0	0	697	0	0	699	0	0	702
bulls (>4)	80	0,56	45	123	0,55	67	121	0,52	63	124	0,52	65	123	0,58	71	116	0,54	64	116	0,53	61	140	0,54	76	132	0,52	69	167	0,54	90	153	0,52	80	132	0,62	86	118	0,52	62	105	0,53	56	99	0,53	53	98
young bulls	2815	0,30	838	3033	0,26	789	3213	0,25	797	3478	0,28	975	3716	0,40	1476	3533	0,27	942	3526	0,26	907	3280	0,34	1119	2784	0,34	963	2356	0,32	744	2177	0,30	659	2139	0,28	603	2161	0,26	597	2179	0,28	620	2176	0,29	625	2169
total sales	1995		2160	1996		1995	1997		1347	1998		1606	1999		2764	2000		3268	2001		2697	2002		2606	2003		2200	2004		1382	2005		1292	2006		1270	2007		1305	2008		1308	2009		1303	2010
total number	9809			9862,2			9871			10706			11576			11447	0,29		10113	0,27		8869	0,29		7628	0,29		6655	0,21		6518	0,20		6544	0,19		8589	0,20		6572	0,20		6556	0,20		6552

	1995	1996	1997	1998	1999
sales	1855	1692	988	1209	1409
slaugh	248	252	303	343	343
other	50	50	50	50	1000
total	2153	1994	1341	1602	2752

year	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
sales																
young bulls	838	789	797	975	1476	942	907	1119	963	744	659	603	597	620	625	
bulls	45	45	83	85	71	84	81	78	69	90	80	88	62	58	53	
heifers	184	179	39	42	575	589	578	534	487	125	128	127	121	128	126	
cows	1093	960	449	524	642	1673	1150	878	660	423	427	472	525	507	497	
total bulls	883	834	659	1040	1547	1006	969	1195	1033	834	739	670	659	676	677	
total females	1277	1138	488	566	1217	2262	1728	1412	1167	548	553	599	546	632	628	
total	2160	1972	1347	1606	2764	3266	2697	2606	2200	1382	1292	1270	1305	1306	1303	
numbers																
young bulls	2815	3033	3213	3478	3716	3533	3526	3280	2794	2356	2177	2139	2161	2179	2176	2169
bulls	80	123	121	124	123	118	116	140	132	167	153	132	118	105	99	98
heifers	3644	3853	3886	4221	4633	4351	3938	3489	3182	2645	2587	2645	2621	2648	2668	2657
cows	3270	2854	2652	2864	3104	3445	2533	1981	1520	1487	1600	1626	1689	1640	1615	1627
total bulls	2895	3155	3334	3601	3839	3651	3642	3420	2926	2523	2330	2271	2279	2284	2275	2268
total females	6914	6707	6538	7105	7737	7795	6472	5469	4702	4132	4186	4273	4311	4288	4281	4284
total	9809	9862	9871	10706	11576	11447	10113	8869	7628	6655	6518	6544	6589	6572	6556	6552
Culling rate with pressure on females culling																
young bulls	30%	26%	25%	28%	40%	27%	26%	34%	34%	32%	30%	28%	28%	28%	28%	
bulls	56%	36%	52%	52%	58%	54%	53%	54%	52%	54%	52%	52%	52%	53%	53%	
heifers	5%	5%	1%	1%	12%	14%	15%	15%	15%	5%	5%	5%	5%	5%	5%	
cows	33%	34%	17%	18%	21%	49%	45%	44%	45%	28%	27%	29%	31%	31%	31%	
total bulls	30%	26%	28%	29%	40%	26%	27%	35%	35%	33%	32%	30%	29%	30%	30%	
total females	18%	17%	7%	8%	18%	29%	27%	28%	25%	13%	13%	14%	15%	15%	15%	
total	22%	20%	14%	15%	24%	29%	27%	29%	29%	21%	20%	19%	20%	20%	20%	

SIMULATION WITHOUT PRESSURE ON FEMALES CULLING

females	ef 1995	tx ref.	Ref.	ef 1996	tx ref.	Ref.	ef 199	tx ref.	Ref.	ef 1998	tx ref.	Ref.	ef 199	tx ref.	Ref.	ef 200	tx ref.	Ref.	ef 200	tx ref.	Ref.	ef 200	tx ref.	Ref.	ef 200	tx ref.	Ref.	ef 200	tx ref.	Ref.	ef 2005	tx ref.	Ref.	ef 2006	tx ref.	Ref.	ef 2007	tx ref.	Ref.	ef 200	tx ref.	Ref.	ef 200	tx ref.	Ref.	ef 2010
>9 ans	167	0,9	150	52	0,9	47	23	0,3	7	101	0,3	30	289	0,33	95	404	0,3	121	460	0,3	138	515	0,3	155	530	0,3	159	551	0,3	165	620	0,3	186	638	0,3	191	638	0,3	191	607	0,3	182	671	0,3	201	688
8 à 9	182	0,8	146	93	0,8	74	124	0,3	37	320	0,3	96	326	0,33	108	289	0,3	87	315	0,3	94	282	0,3	85	298	0,3	69	361	0,3	114	339	0,3	102	322	0,3	97	274	0,3	82	402	0,3	121	365	0,3	109	359
7 à 8	318	0,7	221	420	0,7	294	487	0,3	140	475	0,3	143	439	0,33	145	473	0,3	142	424	0,3	127	448	0,3	135	573	0,3	172	510	0,3	153	484	0,3	145	412	0,3	124	804	0,3	181	548	0,3	164	539	0,3	162	645
6 à 7	715	0,4	286	794	0,4	316	606	0,2	121	561	0,2	112	619	0,22	136	558	0,2	112	590	0,2	118	754	0,2	151	671	0,2	134	637	0,2	127	543	0,2	109	795	0,2	159	721	0,2	144	709	0,2	142	849	0,2	170	872
5 à 6	1013	0,2	203	774	0,2	155	836	0,1	64	702	0,1	70	639	0,11	70	690	0,1	69	882	0,1	88	785	0,1	76	745	0,1	75	635	0,1	63	930	0,1	93	844	0,1	84	830	0,1	83	993	0,1	99	1020	0,1	102	1037
4 à 5	877	0,1	88	721	0,1	72	796	0,1	80	725	0,1	73	791	0,11	87	1031	0,1	103	918	0,1	92	872	0,1	87	742	0,1	74	1088	0,1	109	987	0,1	99	970	0,1	97	1181	0,1	118	1193	0,1	119	1213	0,1	121	1284
3 à 4	617	0,1	82	902	0,1	90	779	0,05	39	850	0,05	42	1114	0,055	81	1017	0,05	51	966	0,05	48	823	0,05	41	1205	0,05	60	1093	0,05	55	1075	0,05	54	1287	0,05	84	1322	0,05	86	1344	0,05	87	1423	0,05	71	1499
2 à 3	1023	0,1	102	883	0,1	88	867	0	0	1136	0	0	1038	0	0	1017	0	0	866	0	0	1266	0	0	1151	0	0	1132	0	0	1355	0	0	1392	0	0	1415	0	0	1498	0	0	1578	0	0	1648
1 à 2	901	0	0	885	0	0	1159	0	0	1059	0	0	1153	0,1	115	911	0	0	1335	0	0	1212	0	0	1191	0	0	1426	0	0	1485	0	0	1490	0	0	1578	0	0	1661	0	0	1735	0	0	1819
< 1	903	0	0	1183	0	0	1081	0	0	1178	0	0	1329	0,3	399	1405	0	0	1275	0	0	1254	0	0	1501	0	0	1542	0	0	1568	0	0	1659	0	0	1749	0	0	1826	0	0	1915	0	0	2011
cows (>4)	3270	0,33	1093	2854	0,34	960	2852	0,17	449	2884	0,18	524	3104	0,21	642	3445	0,18	633	3569	0,18	658	3656	0,19	690	3560	0,20	703	3801	0,19	732	3902	0,19	733	3981	0,19	752	4229	0,19	798	4452	0,19	828	4657	0,19	865	4886
heifers	3644	0,05	184	3853	0,05	179	3886	0,01	39	4221	0,01	42	4633	0,12	575	4351	0,01	51	4442	0,01	48	4557	0,01	41	5048	0,01	60	5193	0,01	55	5463	0,01	54	5827	0,01	64	8062	0,01	88	6329	0,01	67	6651	0,01	71	6978

bulls	ef 1995	tx ref.	Ref.	ef 1996	tx ref.	Ref.	ef 199	tx ref.	Ref.	ef 1998	tx ref.	Ref.	ef 199	tx ref.	Ref.	ef 200	tx ref.	Ref.	ef 200	tx ref.	Ref.	ef 200	tx ref.	Ref.	ef 200	tx ref.	Ref.	ef 200	tx ref.	Ref.	ef 2005	tx ref.	Ref.	ef 2006	tx ref.	Ref.	ef 2007	tx ref.	Ref.	ef 200	tx ref.	Ref.	ef 200	tx ref.	Ref.	ef 2010
>9 ans	1	0,7	1	1	0,7	0	0	0,7	0	0	0,7	0	1	0,77	1	1	0,7	1	2	0,7	1	2	0,7	1	2	0,7	1	2	0,7	1	2	0,7	1	2	0,7	1	2	0,7	2	2	0,7	1	3	0,7	2	3
8 à 9	1	0,7	1	1	0,7	1	1	0,7	1	2	0,7	2	4	0,77	3	5	0,7	4	4	0,7	3	4	0,7	3	4	0,7	3	5	0,7	3	4	0,7	3	6	0,7	4	5	0,7	3	7	0,7	5	7	0,7	5	7
7 à 8	2	0,5	1	2	0,5	1	4	0,5	2	6	0,5	4	12	0,55	7	8	0,5	4	9	0,5	4	7	0,5	4	9	0,5	5	8	0,5	4	12	0,5	6	9	0,5	5	14	0,5	7	15	0,5	7	14	0,5	7	15
6 à 7	4	0,4	2	6	0,4	3	14	0,4	5	20	0,4	8	15	0,44	7	14	0,4	6	13	0,4	5	16	0,4	6	14	0,4	6	20	0,4	8	18	0,4	8	24	0,4	10	25	0,4	10	24	0,4	10	26	0,4	10	27
5 à 6	13	0,4	5	23	0,4	9	34	0,4	14	26	0,4	10	26	0,44	12	21	0,4	9	27	0,4	11	24	0,4	10	34	0,4	14	27	0,4	11	41	0,4	18	42	0,4	17	41	0,4	17	44	0,4	18	45	0,4	18	46
4 à 5	59	0,8	35	88	0,8	53	67	0,6	40	67	0,6	40	64	0,66	42	68	0,6	41	82	0,6	37	67	0,6	52	69	0,6	42	105	0,6	63	107	0,6	64	105	0,6	63	112	0,6	67	115	0,6	69	117	0,6	70	124
3 à 4	299	0,7	209	227	0,7	159	229	0,7	160	219	0,7	153	301	0,77	232	211	0,7	147	296	0,7	207	236	0,7	165	357	0,7	250	365	0,7	255	359	0,7	251	361	0,7	287	392	0,7	274	398	0,7	279	422	0,7	295	444
2 à 3	772	0,7	540	780	0,7	546	743	0,7	520	1023	0,7	716	934	0,77	719	1005	0,7	704	804	0,7	563	1215	0,7	850	1240	0,7	868	1219	0,7	854	1297	0,7	908	1333	0,7	933	1355	0,7	949	1434	0,7	1004	1511	0,7	1058	1578
1 à 2	884	0,1	88	843	0,1	84	1159	0,1	116	1059	0,1	106	1153	0,11	127	911	0,1	91	1377	0,1	136	1408	0,1	141	1383	0,1	136	1471	0,1	147	1511	0,1	151	1537	0,1	154	1628	0,1	163	1714	0,1	171	1789	0,1	179	1877
< 1	860	0	0	1183	0	0	1081	0	0	1178	0	0	1329	0,3	399	1405	0	0	1435	0	0	1411	0	0	1501	0	0	1542	0	0	1568	0	0	1659	0	0	1749	0	0	1826	0	0	1915	0	0	2011
bulls (>4)	80	0,56	45	123	0,55	67	121	0,52	63	124	0,52	65	123	0,58	71	118	0,54	64	116	0,53	61	140	0,54	76	132	0,52	69	167	0,54	90	182	0,53	97	189	0,53	100	199	0,53	106	207	0,53	110	217	0,53	113	222
young bulls	2815	0,30	638	3033	0,28	789	3213	0,25	797	3478	0,26	975	3718	0,40	1478	3533	0,27	942	3912	0,23	907	4266	0,27	1156	4481	0,28	1256	4597	0,27	1256	4735	0,28	1310	4910	0,28	1354	5122	0,27	1386	5372	0,27	1454	5618	0,27	1532	5911
total sales	1995		2160	1996		1995	1997		1347	1998		1606	1999		2764	2000		1690	2001		1875	2002		1964	2003		2089	2004		2133	2005		2194	2006		2270	2007		2356	2008		2456	2009		2581	2010
total number	9809			9862.2			9871			10706			11578			11447	0,15		12058	0,14		12621	0,16		13222	0,18		13758	0,16		14282	0,15		14907	0,15		15612	0,15		16361	0,15		17157	0,15		17996

year	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
sales																
young bulls	638	789	797	975	1478	942	907	1156	1256	1256	1310	1354	1386	1454	1532	
bulls	45	45	83	85	71	84	81	78	89	90	97	100	106	110	113	
heifers	184	179	39	42	575	51	48	41	60	55	54	84	66	67	71	
cows	1093	960	449	524	842	633	658	690	703	732	733	752	798	826	865	
total bulls	883	834	859	1040	1547	1006	969	1232	1326	1346	1407	1453	1491	1564	1645	
total females	1277	1138	488	566	1217	684	706	731	764	787	787	816	864	893	937	
without pres	2160	1972	1347	1606	2764	1690	1675	1964	2089	2133	2194	2270	2356	2459	2581	
with pressur	2160	1972	1347	1606	2764	3266	2897	2606	2200	1382	1292	1270	1305	1308	1303	
numbers																
young bulls	2815	3033	3213	3478	3716	3533	3912	4268	4461	4597	4735	4910	5122	5372	5636	5911
bulls	80	123	121	124	123	118	116	140	132	167	182	169	199	207	212	222
heifers	3644	3853	3886	4221	4633	4351	4442	4557	5048	5193	5463	5827	6062	6329	6651	6978
cows	3270	2854	2652	2884	3104	3445	3589	3656	3560	3801	3902	3981	4229	4452	4657	4886
total bulls	2895	3155	3334	3601	3839	3651	4027	4408	4613	4764	4917	5099	5321	5579	5850	6132
total females	6914	6707	6538	7105	7737	7795	8031	8213	8608	8994	9365	9809	10291	10781	11307	11864
without pres	9809	9862	9871	10706	11578	11447	12058	12621	13222	13758	14282	14907	15812	16381	17157	17996
with pressur	9809	9862	9871	10706	11578	11447	10113	8869	7628	6655	6518	6544	6589	6572	6556	6552
Culling rate without pressure on females culling																
young bulls	30%	26%	25%	26%	40%	27%	23%	27%	28%	27%	28%	26%	27%	27%	27%	
bulls	56%	36%	52%	52%	58%	54%	53%	54%	52%	54%	53%	53%	53%	53%	53%	
heifers	5%	5%	1%	1%	12%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	
cows	33%	34%	17%	18%	21%	18%	18%	19%	20%	19%	19%	19%	19%	19%	19%	
total bulls	30%	26%	28%	29%	40%	28%	24%	28%	29%	28%	29%	29%	28%	28%	28%	
total females	18%	17%	7%	8%	16%	9%	9%	9%	9%	9%	8%	8%	8%	8%	8%	
total	22%	20%	14%	15%	24%	15%	14%	16%	16%	16%	15%	15%	15%	15%	15%	